Portland West Quadrangle, Maine

Surficial geologic mapping by
Woodrow B. Thompson

Digital cartography by:
Robert A. Johnston

Robert G. Marvinney
State Geologist

Cartographic design and editing by:
Robert D. Tucker

Funding for the preparation of this map was provided in part by the U.S. Geological Survey Cooperative Geological Mapping (COGEOMAP) Program, Cooperative Agreement No. 14-08-0001-A0520.

Maine Geological Survey

Address: 22 State House Station, Augusta, Maine 04333
Telephone: 207-287-2801 **E-mail:** nrimc@state.me.us
Home page: http://www.state.me.us/doc/nrimc/nrimc.htm

Open-File No. 97-51
1997

For additional information, see Open-File Report 97-66.

SURFICIAL GEOLOGY OF MAINE

Continental glaciers like the ice sheet now covering Antarctica probably extended across Maine several times during the Pleistocene Epoch, between about 1.5 million and 10,000 years ago. The slow-moving ice superficially changed the landscape as it scraped over mountains and valleys, eroding and transporting boulders and other rock debris for miles. The sediments that cover much of Maine are largely the product of glaciation. Glacial ice deposited some of these materials, while others washed into the sea or accumulated in meltwater streams and lakes as the ice receded. Earlier stream patterns were disrupted creating hundreds of ponds and lakes across the state. The map at left shows the pattern of glacial sediments in the Portland West quadrangle.

The most recent "Ice Age" in Maine began about 25,000 years ago, when an ice sheet spread southward over New England (Stone and Borns, 1986). During its peak, the ice was several thousand feet thick and covered the highest mountains in the state. The weight of this huge glacier actually caused the land surface to sink hundreds of feet. Rock debris frozen into the base of the glacier abraded the bedrock surface over which the ice flowed. The grooves and fine scratches (striations) resulting from this scraping process are often seen on freshly exposed bedrock (**Figure 1**), and they are important indicators of the direction of ice movement. Erosion and sediment deposition by the ice sheet combined to give a streamlined shape to many hills, with their long dimension parallel to the direction of ice flow. Some of these hills (drumlins) are composed of dense glacial sediment (till) plastered under great pressure beneath the ice.

A warming climate forced the ice sheet to start receding as early as 21,000 years ago, soon after it reached its southernmost position on Long Island (Sirkin, 1986). The edge of the glacier withdrew from the continental shelf east of Long Island and reached the present position of the Maine coast by 13,800 years ago (Dorion, 1993). Even though the weight of the ice was removed from the land surface, the Earth's crust did not immediately spring back to its normal level. As a result, the sea flooded much of southern Maine as the glacier retreated to the northwest. Ocean waters extended far up the Kennebec and Penobscot valleys, reaching present elevations of up to 420 feet in the central part of the state.

Great quantities of sediment washed out of the melting ice and into the sea, which was in contact with the receding glacier margin. Sand and gravel accumulated as deltas and submarine fans where streams discharged along the ice front, while the finer silt and clay dispersed across the ocean floor (**Figures 2, 3**). The shells of clams, mussels, and other invertebrates are found in the glacial-marine clay that blankets lowland areas of southern Maine. Fossil plant material has been found in a few places in the clay (**Figures 5-7**). Age dates on these fossils tell us that ocean waters covered parts of Maine until about 11,000 years ago, when the land surface rebounded as the weight of the ice sheet was removed.

Meltwater streams deposited sand and gravel in tunnels within the ice. These deposits remained as ridges (eskers) when the surrounding ice disappeared. Maine's esker systems can be traced for up to 100 miles, and are among the longest in the country.

Other sand and gravel deposits formed as mounds (kames) and terraces adjacent to melting ice, or as outwash in valleys in front of the glacier. Many of these water-laid deposits are well layered, in contrast to the chaotic mixture of boulders and sediment of all sizes (till) that was released from dirty ice without subsequent reworking. Ridges consisting of till or washed sediments (moraines; **Figure 4**) were constructed along the ice margin in places where the glacier was still actively flowing and conveying rock debris to its terminus. Moraine ridges are abundant in the zone of former marine submergence, where they are useful indicators of the pattern of ice retreat.

The last remnants of glacial ice probably were gone from Maine by 10,000 years ago. Large sand dunes accumulated in late-glacial time as winds picked up outwash sand and blew it onto the east sides of river valleys, such as the Androscoggin and Saco valleys. The modern stream network became established soon after deglaciation, and organic deposits began to form in peat bogs, marshes, and swamps. Tundra vegetation bordering the ice sheet was replaced by changing forest communities as the climate warmed (Davis and Jacobson, 1985). Geologic processes are by no means dormant today. Rivers continue to erode the land, worldwide sea level is gradually rising against Maine's coast, and landslides occur where slopes are unstable (**Figure 8**).

References Cited

Davis, R. B., and Jacobson, G. L., Jr., 1985, Late-glacial and early Holocene landscapes in northern New England and adjacent areas of Canada: Quaternary Research, v. 23, p. 341-368.

Devin, S. C., and Sandford, T. C., 1990, Stability of natural slopes in the Presumpscot Formation: Maine Geological Survey, Open-File 90-24, 75 p.

Dorion, C. C., 1993, A chronology of deglaciation and accompanying marine transgression in Maine: Geological Society of America, Abstracts with Programs, v. 25, no. 2, p. 12.

Sirkin, L., 1986, Pleistocene stratigraphy of Long Island, New York, *in* Caldwell, D. W. (editor), The Wisconsinan stage of the first geological district, eastern New York: New York State Museum, Bull. 455, p. 6-21.

Stone, B. D., and Borns, H. W., Jr., 1986, Pleistocene glacial and interglacial stratigraphy of New England, Long Island, and adjacent Georges Bank and Gulf of Maine, *in* Sibrava, V., Bowen, D. Q., and Richmond, G. M. (editors), Quaternary glaciations in the northern hemisphere: Quaternary Science Reviews, v. 5, p. 39-52.

Thompson, W. B., 1997, Surficial geology of the Portland West 7.5' quadrangle, Cumberland County, Maine: Maine Geological Survey, Open-File Report 97-51r, 10 p.

Figure 1: Glacial grooves on granite ledge at the Toppi pit, Westbrook (**Locality 1**). Direction of ice flow was from right to left (south-southeast). White area is snow cover. The large boulders were deposited as part of a moraine that has been removed by excavation in the area shown here.

Figure 2: Glaciomarine clay (Presumpscot Formation) overlying deformed sand and gravel (marine fan), Toppi pit, Westbrook (**Locality 1**). Two episodes of clay deposition are represented here. Older clay layers (left center) were deformed along with the underlying sand and gravel, while the younger clay beds (top) are horizontal.

Figure 3: Marine fan deposit at the Toppi pit in Westbrook (**Locality 1**), showing progressively finer-grained sediments that washed into the ocean during retreat of glacial ice. The materials seen here grade from sand and gravel at the base of the section to silt and sand at the top.

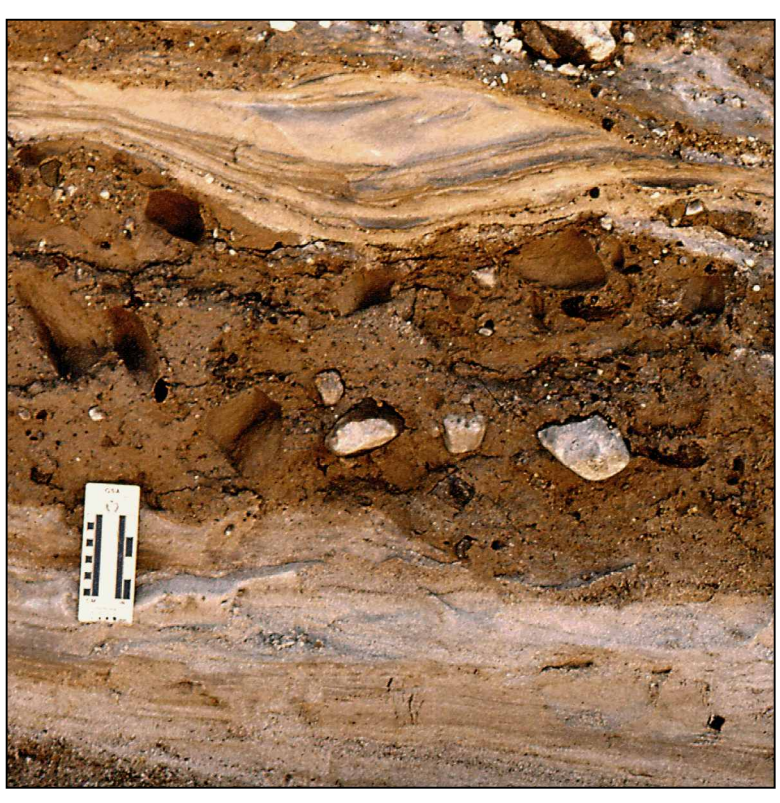

Figure 4: Sand with interbedded flowtill (center) in end moraine at Toppi pit in Westbrook (**Locality 1**). The sand beds were deposited by glacial meltwater currents, but the stony flowtill was emplaced as a debris flow off the glacier margin. Scale card graduated in centimeters and inches.

Figure 5: Scientists collecting fossil plant remains from glaciomarine clay in pit north of the Fore River (**Locality 2**). This gravel pit is the only place in Maine where abundant remains of trees and shrubs have been found in the Presumpscot Formation.

Figure 6: Spruce log embedded in clay at pit shown in Figure 5 (**Locality 2**). This wood is approximately 11,500 years old, yet much of it has the fresh appearance of modern spruce wood. See locality description in Thompson (1997).

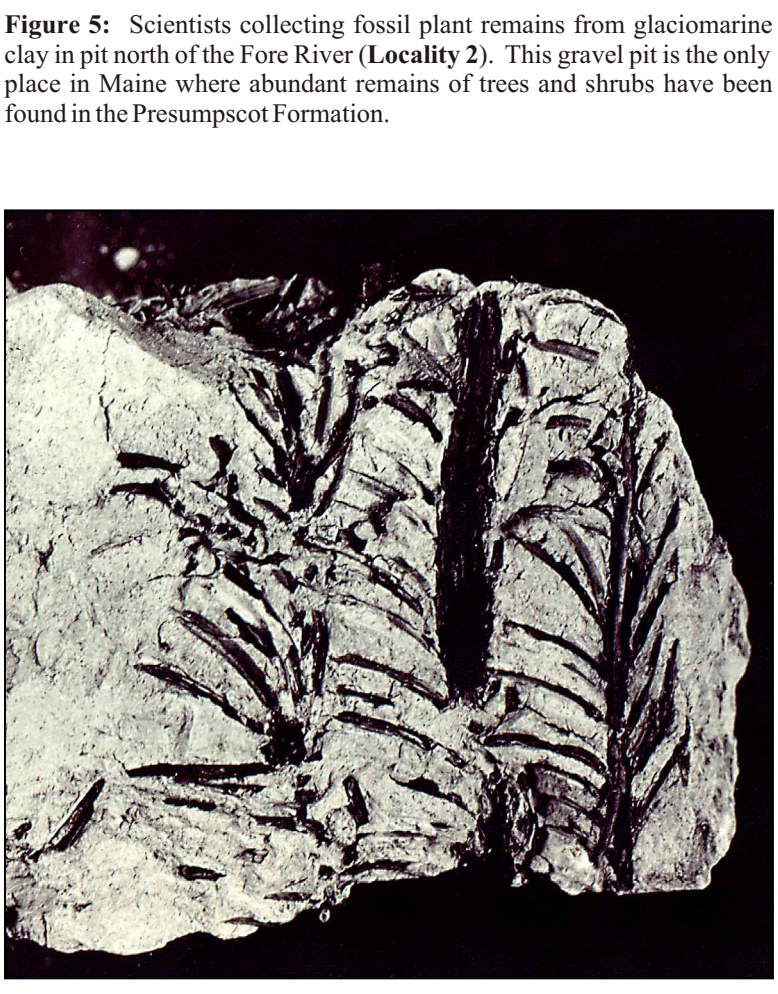

Figure 7 : Imprints of spruce twigs in clay from pit shown in Figure 5 (**Locality 2**). Spruce cones were also found at this site, and some of the needles were so well preserved in the clay that they are still green. See locality description in Thompson (1997).

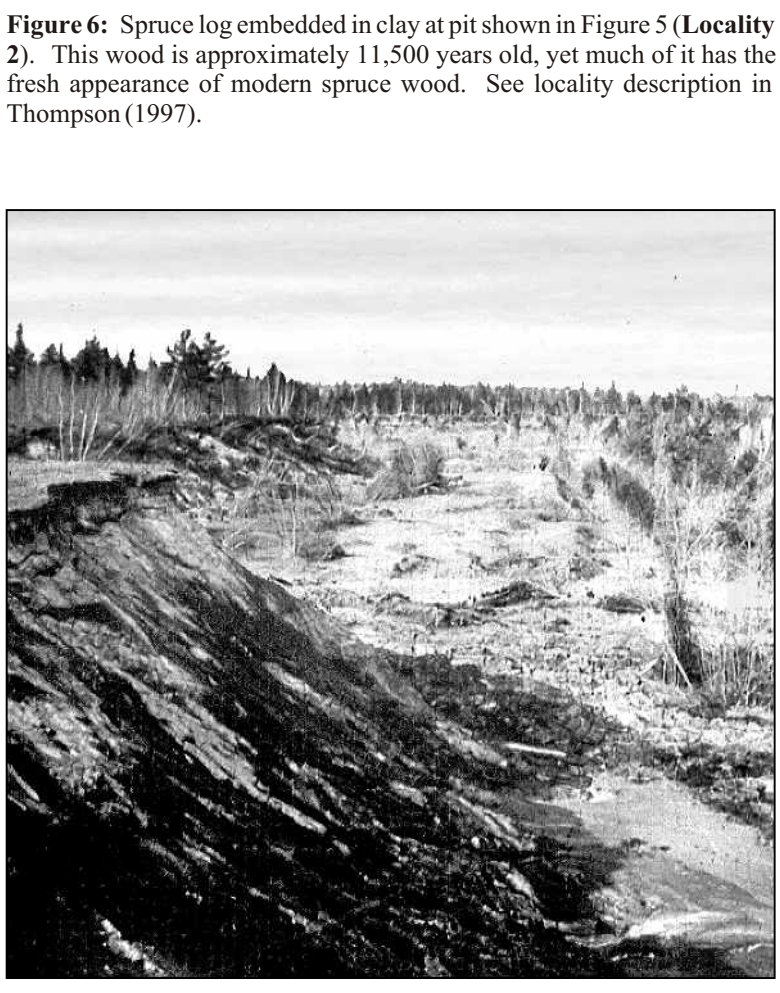

Figure 8: The landslide of November, 1868, in glaciomarine clay at Westbrook (**Locality 3**). This massive slide caused an estimated 20 acres of land to collapse and flow into the Presumpscot River, raising the upstream water level at least 15 feet and causing serious flooding. Photo from Devin and Sandford (1990), courtesy of P. Spiller.